WavesSurfer™ *Accessory*

LeCroy **WS-BATTERY**

BATTERY PACK
User's Manual

LeCroy

WaveSurfer is a trademark of LeCroy Corporation.

Windows is a registered trademark or a trademark of Microsoft Corporation in the United States and other countries.

Foreword

- ◊ Thank you for purchasing LeCroy's BATTERY PACK.
- ◊ Before using the BATTERY PACK, please read this manual thoroughly to gain a good understanding of it. After reading, please keep the manual in a safe place.
- ◊ This manual describes notes on use and basic usage of the BATTERY PACK.

Notes

- ◊ Parts of the contents of this manual may be modified without prior notice for improvements in performance and functions.
- ◊ Reproduction or reprinting of the contents of this manual without prior permission from LeCroy is prohibited.
- ◊ If you have questions about this instrument, please contact LeCroy Corporation. (Refer to the contact address given at the end of this manual.)

Revision History

- ◊ June 2005: 1st edition

Checking the Packing Content

On delivery of the instrument, check each item. If any of the items are missing or there is any damage, immediately contact LeCroy or the sales office in charge.

[Items to be present]

- BATTERY PACK 1

Accessories

- Safety Ground cable ……..1
- User's manual 1

Sending Back for Repairs

If the instrument is inoperable, send it back to LeCroy Corporation. (Refer to the contact address given at the end of this manual.) We will repair it without charge as long as it is under warranty.

When sending back the instrument, explicitly describe the following: product name, serial number, description of the trouble, and name/post/phone number of the contact person.

Table of Contents

■ Safety Requirements 3

■ Product Disposal and Recycling 8

■ Handling the BATTERY PACK 9

(a) Overview of BATTERY PACK 9

(b) When the BATTERY PACK is delivered, ... 9

(c) Storing the BATTERY PACK 10

(d) Unpacking and packing the BATTERY PACK 11

(e) Transporting the BATTERY PACK 12

(f) Longevity of the BATTERY PACK 12

(g) Disposing of the BATTERY PACK 12

■ Overview 13

■ Configuration 13

■ Units 15

(a) BATTERY PACK 15

(b) DC OUT Cable 16

■ When the BATTERY PACK is delivered 17

■ Operation Steps before Using the BATTERY PACK for the First Time 18

(a) Making the Battery Management Function Enabled 18

(b) Oscilloscope Operation with Use of the BATTERY PACK 28

■ Operating Procedures 29

(a) Checking the Remaining Battery Charge Level of the BATTERY PACK 29

(b) Mounting the BATTERY PACK on the Oscilloscope 30

(c) Connecting the DC OUT Cable to the Oscilloscope 31
(d) Starting Up the Oscilloscope 32
(e) Completing the Oscilloscope Setup 33
(f) Completing the BATTERY PACK Operation 33
■ Replacing the BATTERY PACK 35
■ Labels and Indicators 36
(a) Labels 36
(b) POWER Switch 38
(c) Charge Status Indicators 39
■ Specifications 41
(a) Product Specifications[1] (1 of 2) 41
(b) Product Specifications (2 of 2) 42
(c) Certifications 43

■ Safety Requirements

This section contains information and warnings that must be observed to keep the BATTERY PACK operating in a correct and safe condition. You are required to follow generally accepted safety procedures in addition to the safety precautions specified in this section.

Safety Symbols & Terms

The following symbols & terms may appear on the product and they alert you to important safety considerations.

This symbol is used where caution is required. Refer to the accompanying information or documents in order to protect against personal injury or damage to the BATTERY PACK.

This symbol warns of a potential risk of shock hazard.

CAUTION

The CAUTION sign indicates a potential hazard. It calls attention to a procedure, practice or condition which, if not followed, could possibly cause damage to equipment. If a CAUTION is indicated, do not proceed until its conditions are fully understood and met.

WARNING

The WARNING sign indicates a potential hazard. It calls attention to a procedure, practice or condition which, if not followed, could possibly cause bodily injury or death. If a WARNING is indicated, do not proceed until its conditions are fully understood and met.

Before using this product, ensure that its operating environment will be maintained within these parameters;

Temperature : 5 to 40 ^{o}C
Humidity : 30% RH to 90% RH (non-condensing)
Altitude : Up to 2000 m

CAUTION

To avoid personal injury or damage to the BATTERY PACK or the WaveSurfer oscilloscope connected to it, review and comply with the following safety precautions.

- **Use only as intended.**
  The BATTERY PACK is intended to be used only with the LeCroy WaveSurfer series oscilloscopes. Do not connect the DC OUT cable of the BATTERY PACK to any device other than a WaveSurfer oscilloscope. Use of the BATTERY PACK and/or the equipment it is connected to in a manner not specified by the manufacturer(s) may impair the protection mechanisms.

- **Connect and disconnect properly**.
  Do not disconnect the DC OUT cable while the product is operating. Doing so may cause the product to malfunction or the data to be corrupted.

- **Do not use in wet/damp or explosive atmospheres.**

- **For indoor use only.**
  The BATTERY PACK is intended for indoor use and should be operated in a clean, dry, environment.

- **Do not operate with suspected failures.**
  Do not use BATTERY PACK if any part is damaged. All maintenance should be referred to qualified service personnel.

- **Keep product surfaces clean and dry.**

- **Before mounting this product, always check the connecting procedures stated in this instruction manual.**

- **For safety reasons, make sure to turn off the power switch of the product before carrying out wiring of the connectors and cables.**
  Turning on/off the power switch controls the on/off state of the output.

- **Always use the BATTERY CHARGER （WS-BATT-CHRG） to charge this product.**
  If a battery charger other than that specified is used, this may cause an electric shock, a fire, or a malfunction.

- **Use this product after it has been charged fully.**
  This product is generally delivered with an initial remaining battery charge level of approximately 30%.
  When using this product for the first time, always charge it before starting the operation.
  If this product is used not charged fully, this may cause the product to deteriorate. If the output of this product drops, a relevant message will appear on the screen of the oscilloscope. If this occurs, follow the message to replace the BATTERY PACK with a fully charged one or to turn OFF the power to the oscilloscope.
  If the product is used continuously as it is, the output voltage drops and the discharge protective function is activated to shutdown the output, causing the oscilloscope to be faulty or the data to be corrupted.

- **Stop the charging if it is not completed after a charging time of approximately 3 hours at room temperature.**
  By pressing the battery mark on the name label of this product, the LED lamps (five levels) are lit to show the remaining battery charge level. These LED lamps are lit during charging. If the remaining battery charge level exceeds 80%, five LED lamps are lit in red. When the charging is completed, the CHARGE lamp on the battery charger goes off and five LED lamps (red) also go off. If the charging is not completed even after a specified period of charging time has elapsed, contact sales office of LeCroy Corporation.

- **Do not make the positive (+) and negative (-) terminals of this product short-circuited and do not use the product with the positive (+) and negative (-) terminals reversed.**
  Negligence of the above instruction is hazardous and may cause an electric shock, a fire, or a malfunction.

- **Do not touch any leaking fluid from the BATTERY PACK.**
  If leaking fluid enters your eye(s), do not rub your eye(s), immediately wash your eye(s) completely by flowing clean water, and consult a doctor.
  If leaking fluid is sticking to your skin or clothing, immediately wash such part completely by flowing clean water.

- **If the discharging time of this product becomes extremely short, the service life of the BATTERY PACK is expired.**

If this occurs, purchase a new BATTERY PACK. To do so, contact relevant sales person or sales office of LeCroy Corporation.

- **If this product is not used, complete the operation of the oscilloscope and turn OFF the POWER switch of this product.** Failure to do so may cause the oscilloscope to be faulty or the data to be corrupted.
  If the POWER switch is kept turned ON, electric power is consumed continuously to supply the electric power to the standby circuit of the oscilloscope. Eventually, the output voltage becomes lower than the discharging end voltage of the rechargeable, and the discharge protection function is activated to shut-down the output.

- **Do not float the WaveSufer oscilloscope when it is powered by the Battery Pack. Use the safety ground cable to connect oscilloscope to earth ground.**
  When operating the WaveSurfer oscilloscope from AC line power with the standard power cord, the oscilloscope is connected to earth ground via the third-wire in the AC power cord. When operating the WaveSufer oscilloscope with the Battery, there is no connection to earth ground and the oscilloscope is floating.

  Operating the oscilloscope in this manner causes accessible metal parts to be at the same potential of the probe ground leads. This results in a dangerous condition with the potential of elevated voltages present on the oscilloscope causing a shock hazard to the operator and also places stress on the power transformer insulation. Over time this stress may result in dangerous failures which create a shock and fire hazard even during properly grounded operation.

  Without AC power and the standard AC power cord, the WaveSurfer oscilloscope is not grounded and will be floating unless the included grounding cable is connected between the oscilloscope and earth ground. If the oscilloscope probes or channels are connected to circuits or devices that have voltages less than 30Vrms or 42Vpk from earth ground, the ground cable is not required. For any circuits where voltages greater than 30Vrms or 42Vpk may be present, the ground cable must be connected. If the operator is unsure if a higher voltage is present, the ground cable should be used. Operating the oscilloscope in the presence of these voltages without properly grounding, the instrument may

result in electrical shock which can result in serious personal injury or loss of life.

It is also important to remember not to connect a grounded device such as a computer or printer to the oscilloscope while it is floating. To connect a grounded device to the WaveSurfer oscilloscope while using the Battery, the ground cable must be connected between the oscilloscope and earth ground.

WARNING

To avoid electric shock, always connect scope ground terminal to earth ground when WaveSurfer oscilloscope is powered by the BATTERY PACK.

CLEANING

The outside of the BATTERY PACK hardware should be cleaned with a soft cloth dampened with either deionized / distilled water or isopropyl alcohol. Allow the surface to dry completely before returning the instrument to service.

USE AND MAINTENANCE

The BATTERY PACK is a high quality, precision instrument. To maintain accuracy, mechanical shock should be avoided, as well as damage to the cables through excessive bending. All maintenance and component replacement should be referred to qualified personnel.

Product Disposal and Recycling

This electronic product is subject to disposal and recycling regulations that vary by country and region. Many countries prohibit the disposal of waste electronic equipment in standard waste receptacles.

For more information about proper disposal and recycling of your LeCroy product, please visit www.lecroy.com/recycle.

■ Handling the BATTERY PACK

Always strictly observe the warnings and cautions stated in this instruction manual to carefully handle the BATTERY PACK.

The following describes the overview of the BATTERY PACK, conditions at shipment, and how to store, pack, and transport the BATTERY PACK.

When using the BATTERY PACK, strictly observe the contents of each description.

(a) Overview of BATTERY PACK

This BATTERY PACK is composed of a rechargeable manganese lithium-ion battery cell, protective circuit, and peripheral circuitry.

(b) When the BATTERY PACK is delivered,

The BATTERY PACK is generally shipped with approx. 30%-charged status of the rated capacity.
The BATTERY PACK is put in sleep status* at shipment.
*Sleep status: Consumption of the internal circuit is minimized.

The BATTERY PACK doesn't return to the operating state if the charge operation is not done.
After the BATTERY PACK is delivered, it is necessary to charge to full immediately with special charger (WS-BATT-CHRG).
Moreover, the BATTERY PACK enters sleep mode when electrical discharge / not charging lapses for a certain period to minimize power consumption. In this case, neither lighting LED of the remainder amount display, etc., nor the output control with the POWER switch can be done. It is necessary to charge with the BATTERY PACK to release this sleep mode.

(c) Storing the BATTERY PACK

Since a temperature of 25°C or higher has the possibility to deteriorate the BATTERY PACK, store the BATTERY PACK in an atmospheric environment where the temperature (a range of 5°C to 20°C is recommended) and humidity are as low as possible, dust is minimized, and corrosive gas does not exist.
The methods for short-term and long-term storage of the BATTERY PACK are as follows:

Short-term storage
Please keep the BATTERY PACK in less than 80% relative humidity and within the range of –20 °C to +45 °C. There is a possibility that metallic parts may corrode and that a leak may be generated if the BATTERY PACK is kept at the environment with high humidity or beyond the limits of the above-mentioned temperature.

Long-term storage
Please keep the BATTERY PACK within the range of +10 °C to +25 °C and in less than 80% relative humidity when keeping the BATTERY PACK for a long term.
The BATTERY PACK should receive a full charge at least once every six months when keeping it for a long term.

(d) Unpacking and packing the BATTERY PACK

When the BATTERY PACK is delivered, unpack it as described in Figure 1. When packing the BATTERY PACK for some reason, such as repair, use the original carton boxes, bags, and cushion materials, which have been received at delivery, to repack it.

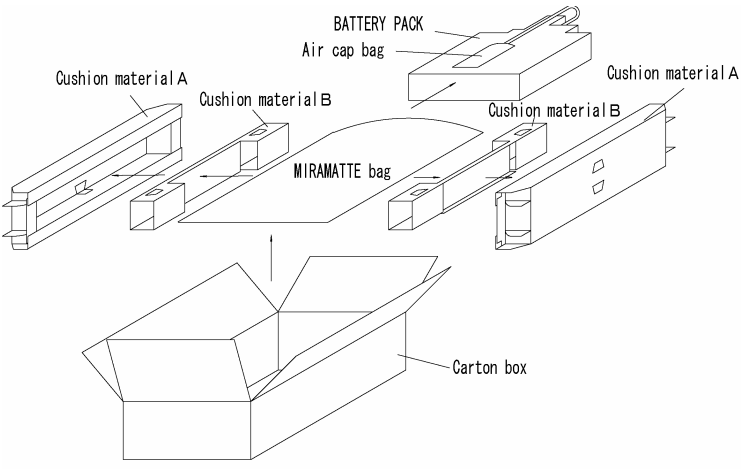

Figure 1. Unpacking of BATTERY PACK

(e) Transporting the BATTERY PACK

The BATTERY PACK has an aggregate Lithium-equivalent greater than 8 grams and falls into the regulatory category of Hazardous Materials class 9 – miscellaneous dangerous goods. Packaging used to transport the BATTERY PACK must meet the Class-9 Dangerous Goods transport requirements and relevant packing instructions. Before shipping the BATTERY PACK, consult with your transportation company on specific measures required for shipment of this class of product.

Please refer to the Web page containing the MSDS (Material Safety Data Sheet) and United Nations test documents as follows;

http://www.lecroy.com/goto/batteryinfo

WARNING

Due to transportation regulations this product must be transported as Class 9 hazardous material

(f) Longevity of the BATTERY PACK

The BATTERY PACK deteriorates while the cycle of the charge and the electrical discharge are repeatedly used.
Since the BATTERY PACK is a lithium-ion battery, the period that can be used according to the storage method and use conditions is restricted.
The expected longevity is 500 times at 20 ℃ as the cycle length.
Since the BATTERY PACK uses an internal chemical reaction, the performance decreases not only while being used but also while it is stored for a long term.
Please refer to page 10 for the storage method.

(g) Disposing of the BATTERY PACK

Battery packs, such as this lithium-ion battery need to be recycled or disposed of according to the local laws and regulations.
When disposing of such battery packs, ask an appropriate recycling company about local laws and regulations.

■ Overview

This product is an accessory specially designed for the Wavesurfer 400 series oscilloscope and intended to supply DC power to the oscilloscope.
Normally, the oscilloscope is operated with the power cord connected to a commercial AC power supply. However, the oscilloscope can also be operated by the power supplied from this product.
This instruction manual describes how to mount this product on the oscilloscope, how to connect the product to the charger and oscilloscope, and how to perform the operation.
Before using this product, thoroughly read this instruction manual to fully understand its contents.

■ Configuration

This product (hereafter referred to as “BATTERY PACK”) is used with it mounted on the rear of the oscilloscope, as shown in Figure 2 below. The DC voltage is output to the BATTERY IN 1 or BATTERY IN 2 connector through the DC OUT cable.
In Figure 2, the DC OUT cable is connected to the DC OUT (indicated on the label) connector of the BATTERY PACK. The CHARGE CONTROL cable of the charger is connected to the CHARGE CONTROL (indicated on the label) connector of the BATTERY PACK only when charging the BATTERY PACK.

NOTE 1 When the AC power cord is connected to the rear of the oscilloscope and commercial AC power is supplied, the operation of the oscilloscope by the AC power takes precedence.

NOTE 2 The BATTERY IN 2 connector on the rear of the oscilloscope is used when replacing the BATTERY PACK to continuously operate the oscilloscope.
For details, see the section, “Replacing the BATTERY PACK”.

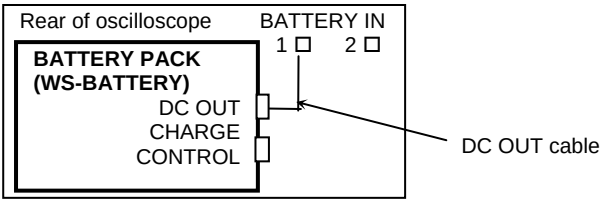

Figure 2. Configuration of Oscilloscope Driven by DC Power (with Use of BATTERY PACK)

When charging the BATTERY PACK, the BATTERY PACK is connected to the BATTERY CHARGER (WS-BATT-CHRG) with the CHARGE CONTROL cable (supplied with the BATTERY CHARGER) and DC OUT cable as shown in Figure 3 below to charge the BATTERY PACK.
The output voltage is output from the BATTERY CHARGER to the DC OUT (indicated on the label) connector through the DC OUT cable during charging. Additionally, the charge voltage is input from the BATTERY CHARGER to the CHARGE CONTROL (indicated on the label) connector on the BATTERY PACK.
For details about how to charge the BATTERY PACK, see the instruction manual for BATTERY CHARGER.

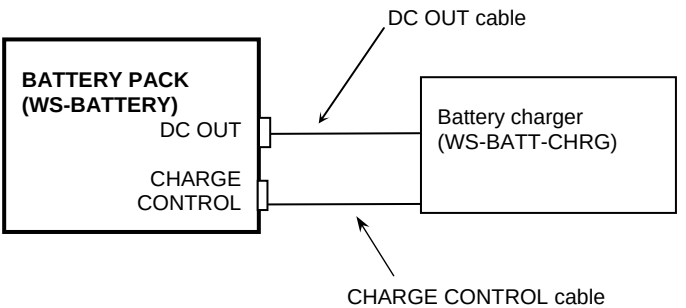

Figure 3. Configurations for Charging of BATTERY PACK

■ Units

(a) BATTERY PACK

Figure 4a shows the outside view of this product.

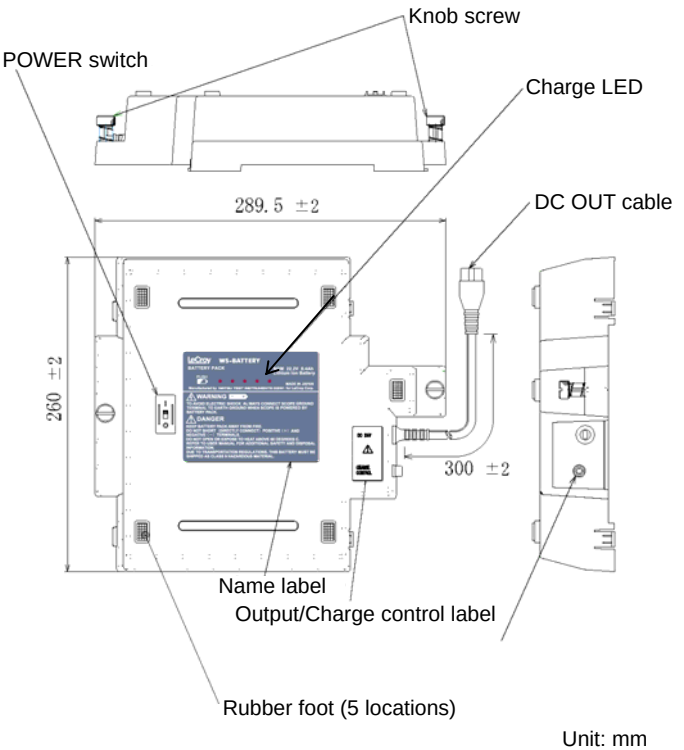

Figure 4a. Outside View of BATTERY PACK

(b) DC OUT Cable

The DC OUT cable is supplied with the BATTERY PACK and it is connected to the BATTERY IN 1 or BATTERY IN 2 connector on the rear of the oscilloscope.
Figure 4b shows the outside view of the DC OUT cable.
2-pin connector consisting of positive (+) and negative (–) terminals is provided on the DC OUT cable as shown in Figure 4b. The connector shape is so designed that it is connected with its correct orientation. When connecting the DC OUT cable to the BATTERY IN 1 or BATTERY IN 2 connector so that the connector shape is matched with the shape of the mating connector on the rear of the oscilloscope, the polarities become correct.

CAUTION

Pay special attention so that the positive (+) and negative (–) terminals of the DC OUT cable are not short-circuited.

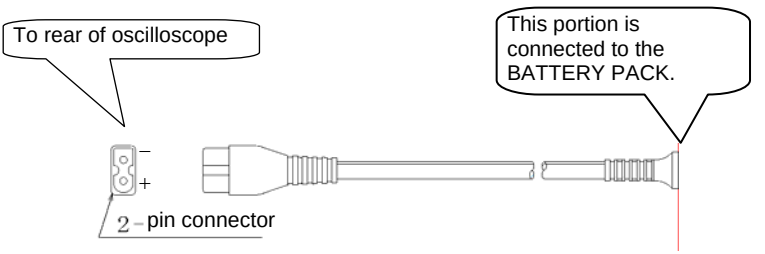

Figure 4b. Outside View of DC OUT Cable

■ When the BATTERY PACK is delivered

The BATTERY PACK is put in the sleep status* at shipment.

*Sleep status: Status, in which the consumption of the internal circuit is minimized.
Neither lighting LED of the remainder amount display, etc. nor the output control with the POWER switch can be done.
The BATTERY PACK enters sleep mode when electrical discharge/not charging lapses for about five days period with a remaining battery charge level of less than 40%.

Please give the BATTERY PACK a full charge at once with special charger (WS-BATT-CHRG) when the BATTERY PACK is delivered.
Please refer to the BATTERY CHARGER manual for the method of charging with the BATTERY PACK.
When the charging of the BATTERY PACK begins, sleep mode is released.
It is necessary to fully charge the BATTERY PACK at least once every six months to prevent deterioration of the BATTERY PACK in performance and longevity when storing it for a long term.
The electrical discharge characteristics for reference are shown in Table 1 when storing the BATTERY PACK at high temperature or for a long term.

Table 1. Electrical Discharge Characteristics

Storage temperature	Storage period	Electrical discharge duration*
25°C	30 days	Approx 3.02Ah
25°C	6 months	Approx 1.93Ah
45°C	30 days	Approx 2.18Ah

＊. The electrical discharge duration (service capacity) is the data that is measured after the BATTERY PACK is charged at temperature 20°C ± 2°C and is discharged by 50%, and is stored within the conditions shown in the above table.

■ Operation Steps before Using the BATTERY PACK for the First Time

The following operation steps are needed only when using the BATTERY PACK for the oscilloscope for the fist time. Additionally, always carry out the following operation steps in an environment where the AC power can be connected.

(a) Making the Battery Management Function Enabled

When using the BATTERY PACK (WS-BATTERY) with the oscilloscope for the first time, follow the steps below to make the battery management function enabled and to restart the operation.

NOTE During the following work, supply the AC power to the oscilloscope and never turn OFF the power during this procedure.

1. Connect the power cord to "LINE" on the rear panel of the oscilloscope.
2. Connect the DC OUT cable of the fully charged BATTERY PACK to "BATTERY IN 1" or "BATTERY IN 2" on the rear panel of the oscilloscope.
   NOTE For details about how to connect the DC OUT cable, see the section, "(C) Connecting the DC OUT Cable", on page 19 in this instruction manual.
3. Turn ON the POWER switch on the BATTERY PACK. Make sure that the green LED to the left of "BATTERY IN" is lit.
   NOTE For details about POWER switch, see the section, "(d) Starting up the Oscilloscope", on page 20 in this instruction manual.
4. Turn ON the ON/STANDBY switch on the front panel of the oscilloscope to turn ON the power.
5. Wait until the XStreamDSO software is started up completely.

6. From the [File] menu, select [Exit] to close the XStreamDSO software.
7. From the [Start] menu of Windows, select [Programs] -> [LeCroy] -> [XStream] -> [Services] -> [Start Battery Management]. (See Figure 5.)

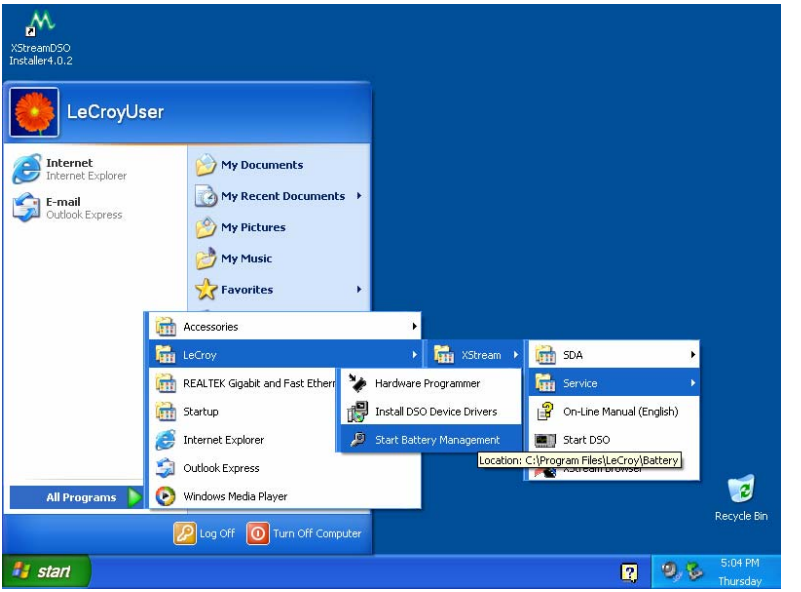

Figure 5. Starting up from [Start] Menu

8. "Battery Management Wizard" is then started up. Any of the dialog boxes shown in Figures 6a to 6c may appear.

- When the dialog box shown in Figure 6a appears, click [Next] and go to step 9.
- When the dialog box shown in Figure 6b appears, the battery management function is already set enabled. When connecting the BATTERY PACK to the oscilloscope for the first time, click [Restart Battery Management Function] and go to step 9.
- When the dialog box shown in Figure 6c appears, the BATTERY PACK cannot be used in this status since the oscilloscope does not have any hardware for the battery management. Click [Cancel]. For details about hardware for the battery management of the oscilloscope, contact the sales person or service department of LeCroy Corporation.

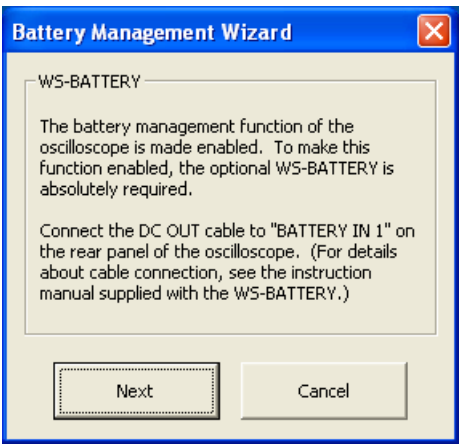
Battery Management Wizard
WS-BATTERY
The battery management function of the oscilloscope is made enabled. To make this function enabled, the optional WS-BATTERY is absolutely required.
Connect the DC OUT cable to "BATTERY IN 1" on the rear panel of the oscilloscope. (For details about cable connection, see the instruction manual supplied with the WS-BATTERY.)
Next
Cancel

Figure 6a. Dialog Box that Appears when Using the Battery Management Function for the First Time.

Figure 6b. Dialog Box that Appears when the Battery Management Function is Already Active.

Battery Management Wizard
WS-BATTERY
Since this oscilloscope does not have any hardware for the battery management, the battery cannot be used.
For details about how to add hardware for the battery management to the oscilloscope, contact the sales person, local sales representative, or service department of LeCroy Corporation.
OK
Cancel

Figure 6c. Dialog Box that Appears when the Hardware Is Not Applicable to the Battery.

9. If the following dialog box appears, click [Exit XStreamDSO Software], and then click [Next].

Figure 7. Dialog Box that Appears when the XStreamDSO Software Is Running.

10. After checking that the DC OUT cable is connected to "BATTERY IN 1" on the rear panel of the oscilloscope, click [Next].

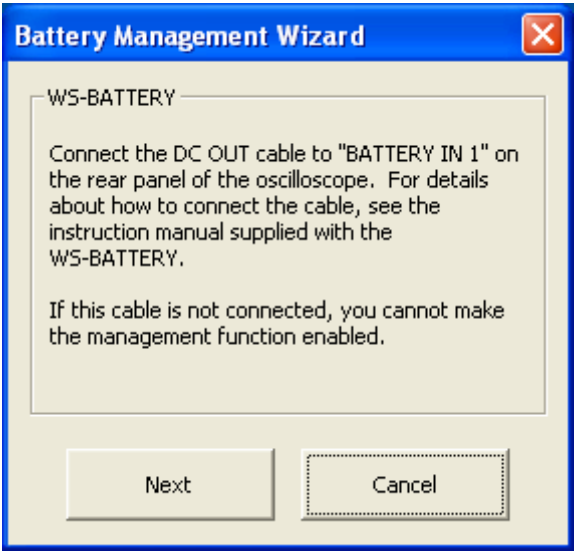
Battery Management Wizard
WS-BATTERY
Connect the DC OUT cable to "BATTERY IN 1" on the rear panel of the oscilloscope. For details about how to connect the cable, see the instruction manual supplied with the WS-BATTERY.
If this cable is not connected, you cannot make the management function enabled.
Next
Cancel

Figure 8. Dialog Box Prompting You to Check that the DC OUT Cable Is Connected Properly.

11. The following dialog box is shown while the battery management function is being set enabled.

Battery Management Wizard
WS-BATTERY
The battery management function is being set enabled now. Please wait for a while.
Next
Cancel

Figure 9. Dialog Box that Appears while the Battery Management Function Is Being Set Enabled.

12. When the following dialog box appears, the battery management function is made enabled after restarting. Click [Restart Now]. The oscilloscope will be restarted automatically.

Figure 10. Dialog Box that Appears when the Setup Process Is Completed.

13. Follow the steps below to check that the battery management function is set enabled. Select the [Start] menu -> [Control Panel] -> [Power Options].

CAUTION

Various settings displayed in "Power options" dialog are set to optimize WaveSurfer. Please do not change these settings.

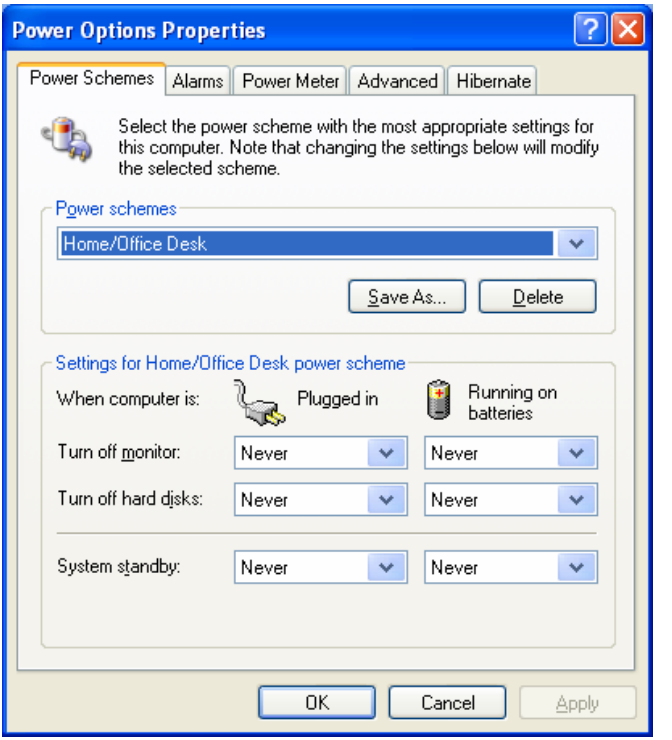

Figure 11. Power Options Dialog Box

14. When the [Power Meter] tab is shown, this means that the battery management function is set enabled.

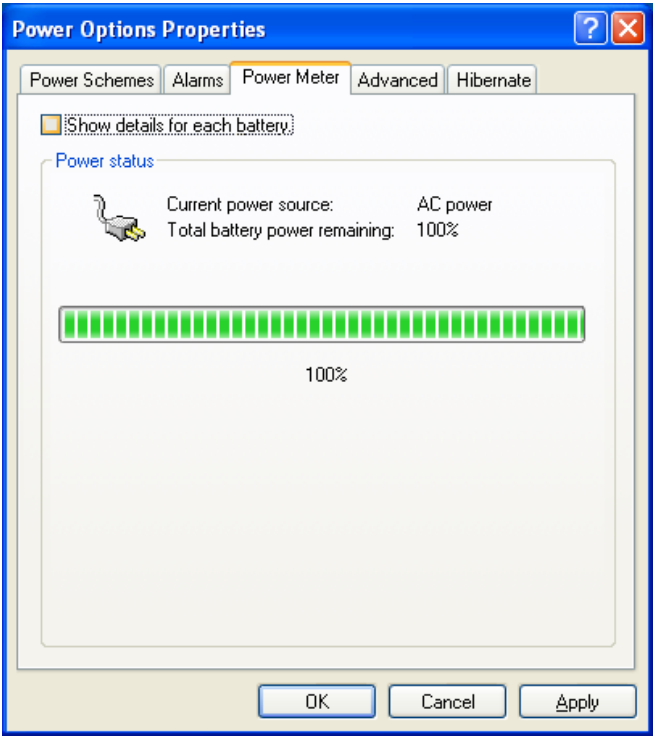

Figure 12. Power Meter Dialog Box

(b) Oscilloscope Operation with Use of the BATTERY PACK

1. When the oscilloscope is operated by the BATTERY PACK, the following icon is automatically shown on the taskbar.

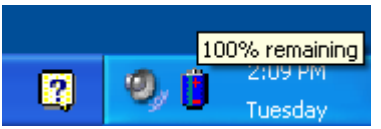

Figure 13. Battery Icon Shown on Taskbar

2. If the remaining battery charge level of the BATTERY PACK becomes 10% or less, the following warning message will appear.

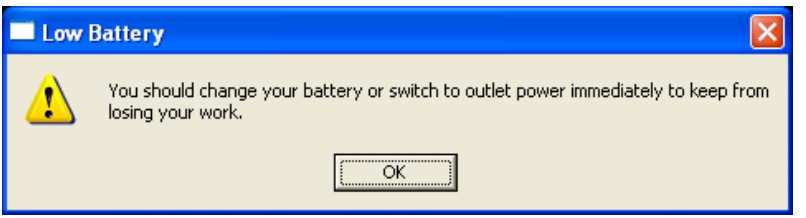

Figure 14. Warning Message that Appears If the Remaining Battery Charge Level Is 10% or Less.

3. If the remaining battery charge level of the BATTERY PACK becomes 5% or less, the battery management function closes (shuts down) the oscilloscope operation.
4. If the remaining battery charge level of the BATTERY PACK is already 5% or less when the oscilloscope is started up, the oscilloscope operation is shut down.

■ Operating Procedures

Operate the BATTERY PACK using the following procedures.

(a) Checking the Remaining Battery Charge Level of the BATTERY PACK

1. An indication switch used to check the remaining battery charge level is provided at the upper portion of the name label of the BATTERY PACK as shown in Figure 15.
   To check the remaining battery charge level, press this switch.
2. Five charge LEDs are arranged to the right of the indication switch. The remaining battery charge level is shown by lit or flashing LED lamps.
   If the remaining battery charge level is small, connect the BATTERY PACK to the BATTERY CHARGER (WS-BATT-CHRG) to charge it.
   NOTE 1 For details about how to charge the BATTERY PACK, see the instruction manual for BATTERY CHARGER.
   NOTE 2 For details about description of charge LED lamp indications, see the section, “Charge LED Lamp Indications”, on page 39.

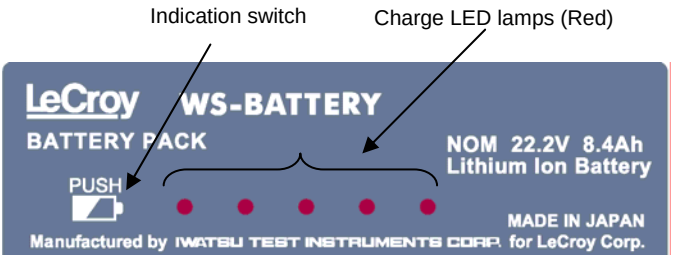

Figure 15. Charge Level Indication and Check

(b) Mounting the BATTERY PACK on the Oscilloscope

1. With the back plate of the BATTERY PACK matched with the rear of the oscilloscope, align the tabs (upper and lower portions, 2 locations in total), which are located on the left when viewed from the rear of the oscilloscope, with the slots in the oscilloscope, and slide them left to insert them into the slots. (See Figure 16.)

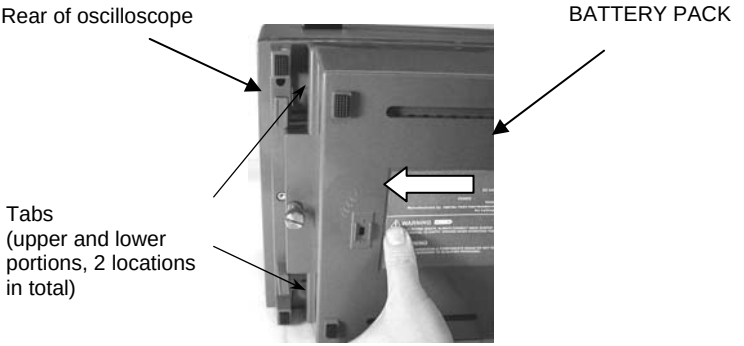

Figure 16. Mounting of BATTERY PACK A (Left Side)

2. Next, align the tabs (upper and lower portions, 2 locations in total), which are located on the right when viewed from the rear of the oscilloscope, with the slots in the oscilloscope and insert them into the slots. (See Figure 17.)

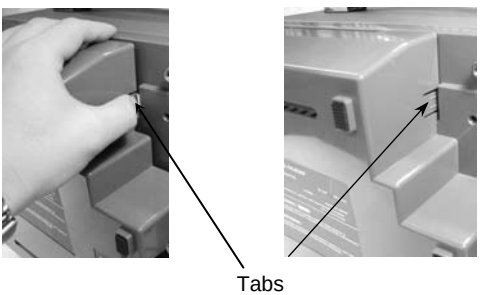

Figure 17. Mounting of BATTERY PACK B (Right Side)

3. Manually turn the screw knobs (left and right portions, 2 locations in total) to fasten the BATTERY PACK to the oscilloscope. (See Figure 18.)
   NOTE Tighten the left and right screw knobs evenly.

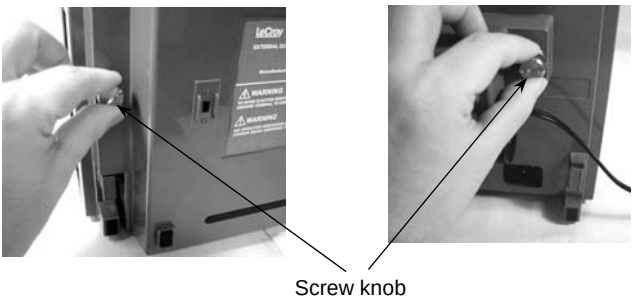

Figure 18. Fastening of BATTERY PACK

(c) Connecting the DC OUT Cable to the Oscilloscope

After the BATTERY PACK has been mounted on the oscilloscope, follow the steps below to connect the DC OUT cable.

1. Connect the DC OUT cable of the BATTERY PACK to the BATTERY IN 1 or BATTERY IN 2 connector at the upper right portion of the rear of the oscilloscope. (See Figure 19.)
   NOTE Pay special attention so that the BATTERY IN connector position meets the orientation of the positive (+) and negative (–) terminals.
   Do not connect the DC OUT cable to the DC IN connector.

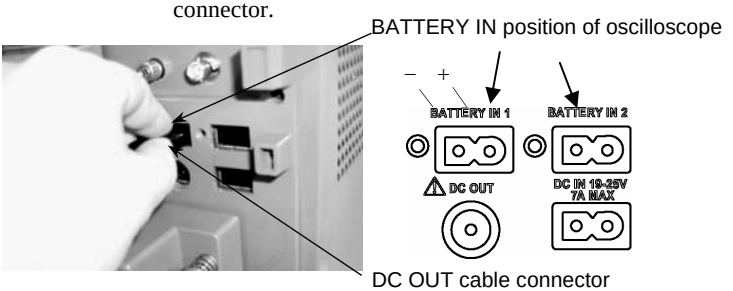

Figure 19. Connection of DC OUT Cable

(d) Starting Up the Oscilloscope

After the oscilloscope and BATTERY PACK have been connected with the DC OUT cable, follow the operation steps below to start up the oscilloscope.

1. Turn ON the POWER switch on the BATTERY PACK. (See Figure 20.)

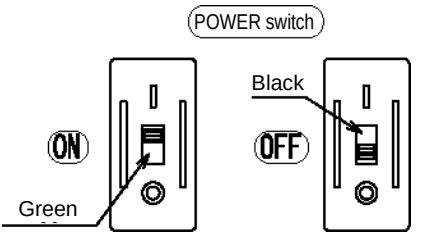

Figure 20. POWER Switch

The BATTERY IN 1 or BATTERY IN 2 LED lamp on the rear of the oscilloscope is then lit. This shows that the oscilloscope is ready for operation by the voltage supplied from the BATTERY PACK.

NOTE 1 When the AC power cord is connected to the rear of the oscilloscope and commercial power is supplied, the operation of the oscilloscope by AC power takes precedence.
The BATTERY PACK automatically switches to the DC power supply operation when the AC power supply is interrupted, even though the AC power supply powers both the AC power supply and DC power supply.
Moreover, the BATTERY PACK automatically switches to AC power supply operation if the AC power supply is connected while the DC power supply is used. In these cases, the switch time of about one second is necessary for the power supply switch in WaveSurfer.
If the AC power supply is connected and the DC power supply is turned off at the same time (or, the cord is pulled out) when the DC power supply is used, WaveSurfer terminates abnormally and data is corrupted because the power supply is interrupted during the switch time

2. Turn ON the ON/Standby switch at the lower left portion of the front panel of the oscilloscope. The oscilloscope is then started up.

NOTE 2 The alert message is displayed on WaveSurfer screen in (page 28 Figure 14) when the charge remainder is low. At this time, follow the instructions that appear on the screen.
Additionally, even though the oscilloscope is driven by the BATTERY PACK, you can check the remaining battery charge level using the procedures stated on page 17.

(e) Completing the Oscilloscope Setup

Follow steps 1 and 2 stated in “Quick Reference Guide” supplied with the oscilloscope (see pages 7 and 8) to complete the oscilloscope setup.

(f) Completing the BATTERY PACK Operation

After the power of the oscilloscope has entered the standby mode, follow the steps below to complete the BATTERY PACK operation.

1. Turn OFF the POWER switch of the BATTERY PACK.
2. Disconnect the DC OUT cable from the BATTERY PACK.

NOTE 3 If the oscilloscope is driven by the DC power and it is not operated for an extended period of time, follow steps (e) and (f) described above to complete the oscilloscope operation and turn OFF the POWER switch of the BATTERY PACK.

NOTE 4 If you do not follow warnings displayed on the screen and you operate the oscilloscope continuously, the electric power of the BATTERY PACK is consumed and the output voltage supplied to the oscilloscope is interrupted forcibly.

(g) Removing the BATTERY PACK from the oscilloscope

1. With the upper and lower tabs at two locations on the right kept pushed, pull the BATTERY PACK slightly toward you to remove it.

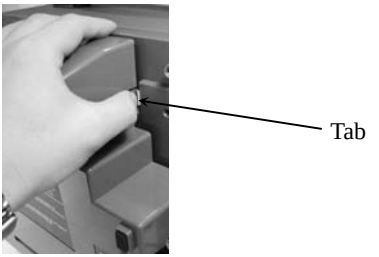

Figure 21. Removal of BATTERY PACK

2. Slide the BATTERY PACK in the direction opposite to that shown in Figure 16 on page 17 (slide rightward) to disengage the tabs on the left from the slots in the oscilloscope.

■ Replacing the BATTERY PACK

If the BATTERY PACK is used to drive the oscilloscope for an extended period of time, it is necessary to replace the BATTERY PACK.
To continuously operate the oscilloscope without powering OFF the oscilloscope, use the BATTERY IN 2 connector on the rear of the oscilloscope.
The following describes how to replace the BATTERY PACK and how to use the BATTERY IN 2 connector.

1. Connect the DC OUT cable of the BATTERY PACK 2 to the BATTERY IN 2 connector on the rear of the oscilloscope.
   NOTE 1 Make sure that the BATTERY PACK 2 is charged fully.
2. Turn ON the POWER switch of the BATTERY PACK 2 to be replaced.
   The LED lamp next to the BATTERY IN 2 connector is lit.
3. Turn OFF the POWER switch of the BATTERY PACK 1.
4. Disconnect the DC OUT cable of the BATTERY PACK 1 from the BATTERY IN 1 connector.
5. Mount the BATTERY PACK 2 on the rear of the oscilloscope.
   NOTE 2 To ensure the operational safety, always mount the BATTERY PACK on the rear of the oscilloscope. When mounting the BATTERY PACK, pay special attention so that the DC OUT cable is not disconnected from the BATTERY IN 2 connector.
   For details about how to mount the BATTERY PACK, see "**(b) Mounting the BATTERY PACK on the Oscilloscope**" in the section, "Operating Procedures", on pages 30 and 31 of the instruction manual.
   NOTE 3 After the battery has been replaced, do not connect two BATTERY PACKs to the BATTERY IN connectors for an extended period of time.

■ Labels and Indicators

(a) Labels

The following labels are attached to the BATTERY PACK.

1. Name label (See Figure 22.)

   Please observe the message and see Safety Requirements on pages 3 to 7.

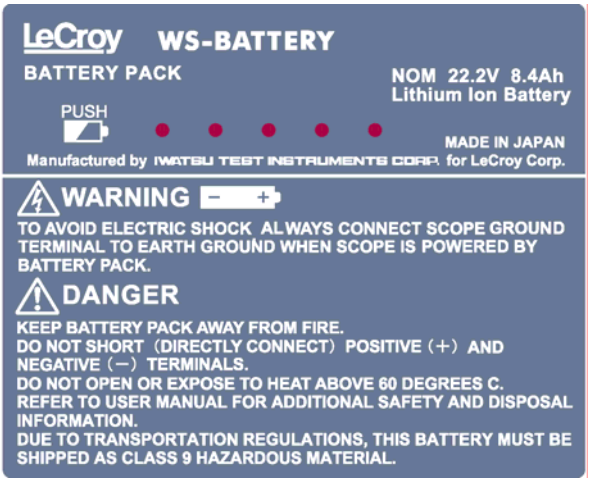
LeCroy
WS-BATTERY
BATTERY PACK
NOM 22.2V 8.4Ah
Lithium Ion Battery
PUSH
MADE IN JAPAN
Manufactured by IWATSU TEST INSTRUMENTS CORP. for LeCroy Corp.
WARNING
TO AVOID ELECTRIC SHOCK ALWAYS CONNECT SCOPE GROUND TERMINAL TO EARTH GROUND WHEN SCOPE IS POWERED BY BATTERY PACK.
DANGER
KEEP BATTERY PACK AWAY FROM FIRE.
DO NOT SHORT (DIRECTLY CONNECT) POSITIVE (+) AND NEGATIVE (−) TERMINALS.
DO NOT OPEN OR EXPOSE TO HEAT ABOVE 60 DEGREES C.
REFER TO USER MANUAL FOR ADDITIONAL SAFETY AND DISPOSAL INFORMATION.
DUE TO TRANSPORTATION REGULATIONS, THIS BATTERY MUST BE SHIPPED AS CLASS 9 HAZARDOUS MATERIAL.

Figure 22. Name Label

2. Output / Charge control label (See Figure 23.)
   The following label is attached to the right of the name label. This label shows the input for the charge control and the output of the DC OUT cable.

Figure 23. Output / Charge Control Label

3. BATTERY PACK label (See Figure 24.)
   The following label is attached to the rear plate surface of the BATTERY PACK (oscilloscope mating surface) and it shows that the rechargeable manganese lithium-ion battery can be recycled.

Figure 24. BATTERY PACK Label

(b) POWER Switch

Move the POWER switch on the BATTERY PACK to the [1] side. The power is turned ON and the green indication is shown. On the contrary, when moving the POWER switch to the [0] side, the power is turned OFF and the black indication is shown. (See Figure 25.)

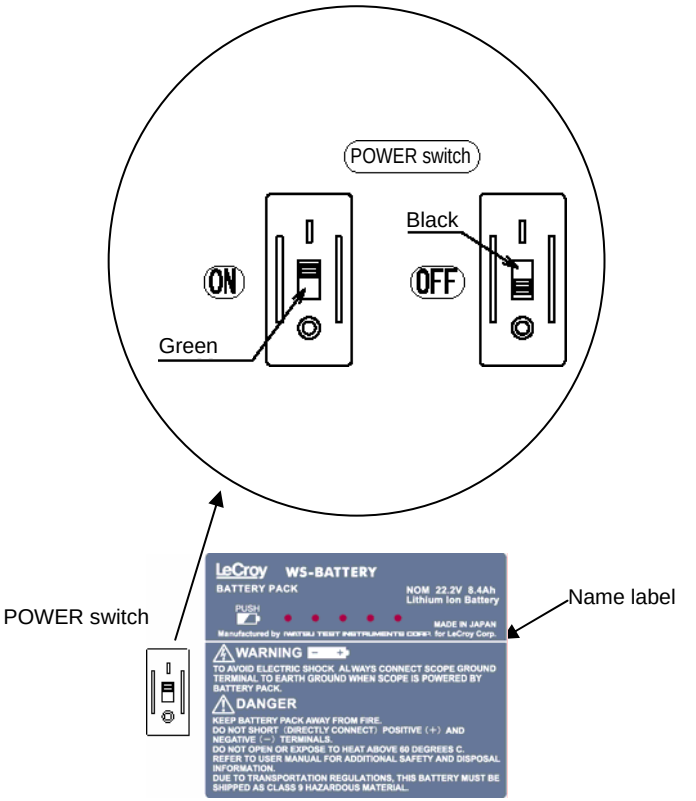
POWER switch
Black
ON
OFF
Green
POWER switch
LeCroy WS-BATTERY
BATTERY PACK
NOM 22.2V 8.4Ah
Lithium Ion Battery
PUSH
MADE IN JAPAN
Manufactured by for LeCroy Corp.
WARNING
TO AVOID ELECTRIC SHOCK ALWAYS CONNECT SCOPE GROUND TERMINAL TO EARTH GROUND WHEN SCOPE IS POWERED BY BATTERY PACK.
DANGER
KEEP BATTERY PACK AWAY FROM FIRE.
DO NOT SHORT (DIRECTLY CONNECT) POSITIVE (+) AND NEGATIVE (−) TERMINALS.
DO NOT OPEN OR EXPOSE TO HEAT ABOVE 60 DEGREES C.
REFER TO USER MANUAL FOR ADDITIONAL SAFETY AND DISPOSAL INFORMATION.
DUE TO TRANSPORTATION REGULATIONS, THIS BATTERY MUST BE SHIPPED AS CLASS 9 HAZARDOUS MATERIAL.
Name label

Figure 25. POWER Switch

(c) Charge Status Indicators

Charge status indicator LED lamps and “Push to Test” switch (battery mark) as shown in Figure 26 are provided at the upper portion of the name label (Figure 22). The following describes the indication contents.

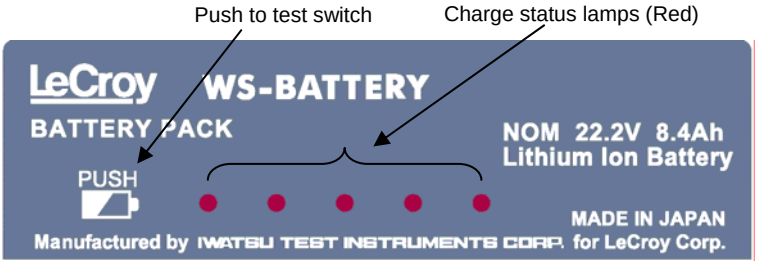

Figure 26. Charge Status Indicators

1. Contents of charge status LED lamp indications
   When pressing the “Push to Test” switch shown in Figure 26, the remaining battery charge level is shown for 4 seconds, as described in Table 2.
   Seven kinds of battery charge status are shown using the lit, off, and flashing states of the LED lamps.

Table 2 Meaning of Charge Status Indicators

Battery charge status	LED lamp status				
Sleep status	●	●	●	●	●
Battery charging request status Remaining level, 0 to 10%	◎	●	●	●	●
Remaining level, 11 to 20%	○	●	●	●	●
Remaining level, 21 to 40%	○	○	●	●	●
Remaining level, 41 to 60%	○	○	○	●	●
Remaining level, 61 to 80%	○	○	○	○	●
Remaining level, 81 to 100%	○	○	○	○	○

○: Lit ●: Off ◎: Flashing

2. Error indicators
   When turning ON the indication switch if an error occurs, the error is indicated for 4 seconds. At this time, the LED lamp(s) is flashing at 2 Hz to show its contents.
   Tables 3 and 4 show the error types during charging and discharging, respectively.

Table 3 Error Indications During Charging

Type	Cause	Contents of LED indications
Over-current	Charger is faulty.	LED lamps are flashing one by one.
Over-voltage	Charger is faulty.	LED lamps are flashing one by one.
Over-charging	Cell balance is faulty.	LED lamps are flashing one by one.
Temperature	Faulty environmental temperature, cell deterioration, etc.	LED lamps 1, 3, and 5 are flashing.

Table 4 Error Indications During Discharging

Type	Cause	Contents of LED indications
Over-current	BATTERY PACK is faulty.	LED lamps 1, 3, and 5 are flashing.
Temperature	Faulty environmental temperature, cell deterioration, etc.	LED lamps 1, 3, and 5 are flashing.

If an indication stated in above Tables 3 and 4 is shown, the BATTERY PACK or BATTERY CHARGER may be faulty. If this occurs, immediately contact the sales office or service center of LeCroy Corporation.

■ Specifications

(a) Product Specifications[1] (1 of 2)

Item	Specifications
<Electrical specifications>	
Rated capacity	8.4 Ah or more [2]
Nominal voltage	22.2 Vdc [3]
Maximum charging voltage	25.2 Vdc
Discharging end voltage	18.0 Vdc
Charging / discharging cycle	6.3 Ah or more (75%) [4]
Charging temperature characteristics	Charging time at a temperature listed below with charging current of 5.0A 5 °C: Approx. 5.0 h 20 °C: Approx. 3.0 h 40 °C: Approx. 3.0 h
Discharging temperature characteristics	Discharging capacity at a temperature listed below with discharging current of 1.8A 5 °C: 7.7 Ah (92%) 20 °C: 8.4 Ah (100%) 40 °C: 8.0 Ah (95%) [5]

1. Specifications are subject to change without prior notice.
2. Discharging capacity when charging and discharging under conditions below.

   Charging: Charging with constant current and voltage (7.5 A, 25.2 V) at an atmospheric temperature of 20 °C ± 2 °C.

   Discharging: Discharging to discharging end voltage (18.0 V) with constant current (1.8 A) at an atmospheric temperature of 20 °C ± 2 °C.
3. Average operating voltage when charging and discharging under conditions stated in 2.
4. Discharging capacity after re-charging after charge / discharge cycle has been performed 500 times at an atmospheric temperature of 20 °C±2 °C under conditions stated in 2.
   Since this product is a lithium-ion battery, the period that can be used according to the storage method and use conditions is restricted.
   The longevity that can be expected is 500 times the cycle length.
5. Numeric value in parentheses ( ) shows the discharging capacity when compared to the fully charged level.

(b) Product Specifications (2 of 2)

Item	Specifications
<Environmental specifications>	
Temperature	Operating (Charge / Discharge) : +5 °C to +40 °C Storage (non-operating) : –20 °C to +45 °C
Humidity	30% RH to 90% RH [6]
Altitude	Operating (Charge / Discharge) : Up to 6,562 ft (2,000 m)
<General specifications>	
Outside dimensions	289.5 (W) × 62.0 (H) × 260.0 (L) [mm]
	Tolerance: 2 [mm]
Length of Safety Ground cable	2000 [mm] ± 20 [mm]
Length of DC OUT cable	300 [mm] ± 20 [mm]
Weight	Approx. 2.6 kg

6. Since operation or storage for an extended period of time under high humidity conditions may lead to malfunction, avoid such operation or storage.
7. Please charge with the BATTERY PACK at the temperature within the range of +5 ℃ to +40 ℃. There is a possibility of the damage of the BATTERY PACK, and leaking electricity when charging it outside this range.
8. The BATTERY PACK is suitable for use in the range of + 5 ℃ to +40 ℃. Use outside this range causes damage.

Operation time of oscilloscope (Reference value)

When using the fully charged BATTERY PACK at 20 °C with the factory shipment panel settings of the oscilloscope, the reference operation time of the oscilloscope is shown below.

- Oscilloscope model 454, 434, 424: Approximately 100 min.
- Oscilloscope model 452, 432, 422: Approximately 140 min.

Note that the above operation time may vary depending on the operating conditions (setup and temperature).

(c) Certifications

EC Declaration of Conformity	Meets intent of the European Council Directives 73/23/EEC for product safety and 89/336/EEC for electromagnetic compatibility. This declaration is based upon compliance of the WS-BATTERY to the following standards: EN 61326: 1997 +A3:2003 EMC requirements for electrical equipment for measurement, control, and laboratory use. EN 55022: 1994+A1: 1995+A2: 1997 Radiated Emissions (Class A) EN 61000-4-2: 1999 Electrostatic discharge (±4kV contact discharge; ±8kV air discharge) EN 61010-1: 2001 Safety requirements for electrical equipment for measurement control and laboratory use

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